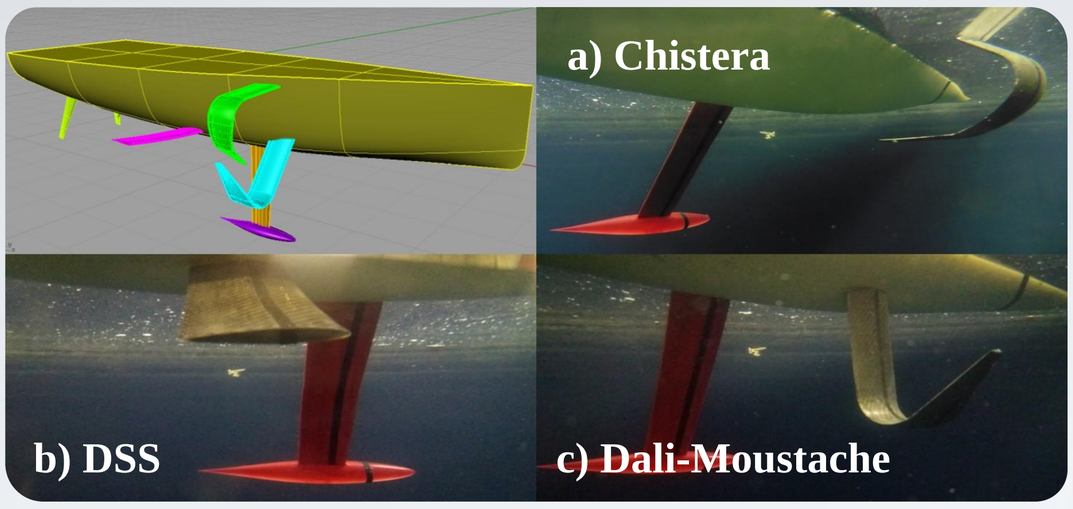
HIGH PERFORMANCE RACING YACHTS

An Experimental Comparison of the Latest Hydrofoil Configurations

INTRODUCTION

Despite the omnipresence of hydrofoil-assisted monohulls and the inherent development phases to refine their design, very little scientific data has reached the public domain. Moreover, following the trend set by the racing yachts, the pleasure craft industry is now looking at the implementation of foils onto yachts and superyachts, with several vessels already built. This poster presents a hydrodynamic comparison of three contemporary options, namely a Dynamic Stability System, a Dali-Moustache and a Chistera foil, that have been towing tank tested on a 1:10 scale model of a 50ft hull.



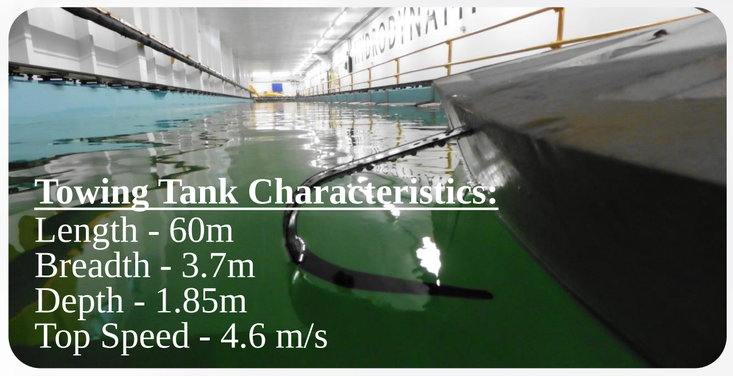
HYDROFOIL CONFIGURATIONS

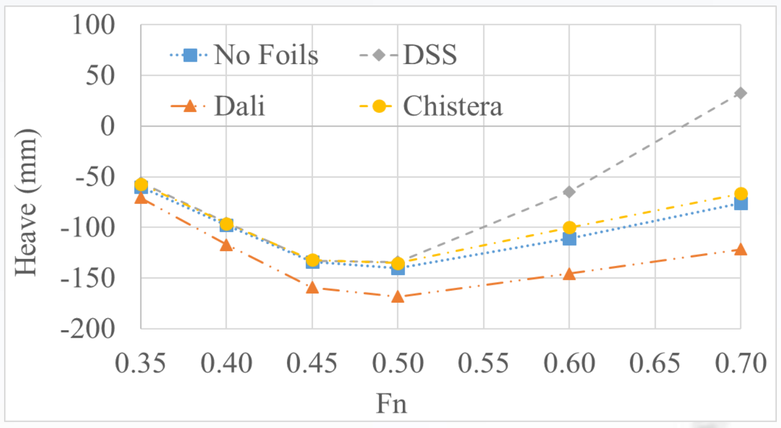
The investigation conducted did not consider the righting moment provided by the foils or issues such as ventilation or cavitation, but instead focused on a quantitative analysis of the hydrodynamic efficiency.

The three current configurations for foil-assisted monohulls investigated are:
a) Chistera foils, recently used on the new Figaro Bénéteau 3 by VPLP Design.
b) Dynamic Stability System (DSS), as found on several yachts and superyachts.
c) Dali-Moustache foils, employed on IMOCA 60s in the last Vendée Globe.

EXPERIMENTAL SETUP

The tests were performed following the ITTC Recommended Procedures and Guidelines for Resistance Test, and all experiments were undertaken in the Hydrodynamic Test Centre at Solent University. All runs were performed for a defined speed, at a constrained heel and yaw angle, with the vessel free to heave and trim. The drag, side force and trim are measured by potentiometers, while the heave is quantified thanks to a linear variable displacement transducer.





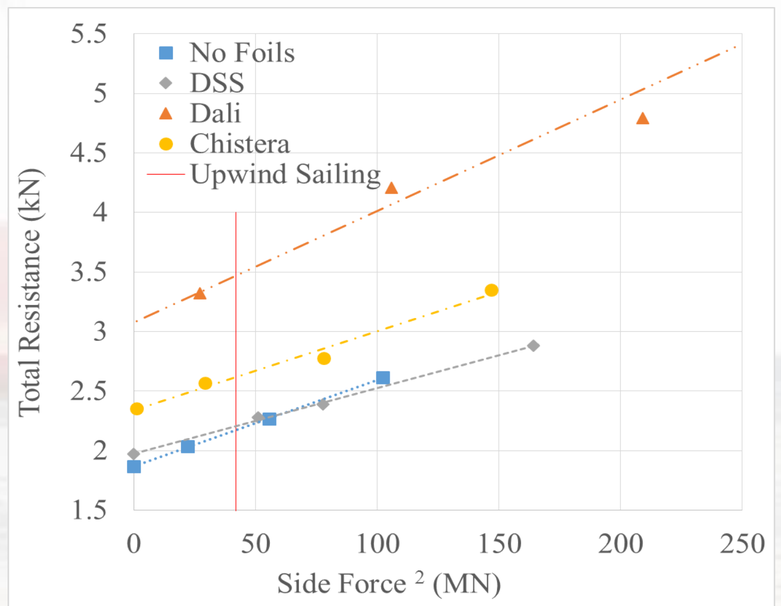
RESULTS: FOILING ABILITY

The measured heave demonstrates the foiling ability of the vessel in each configuration, as well as without any foil. Firstly, no foiling occurs until a Froude number of 0.5, unrealistic for upwind sailing, but achievable downwind. Furthermore, the performance of the Dynamic Stability System is far superior to the Chistera, the latter providing only a marginal improvement from the bare hull. Finally, the Dali-Moustache foil did not exhibit an improvement from a bare hull in this experiment, but however developed the highest side force (albeit at a strong drag penalty).

RESULTS: HYDRODYNAMIC EFFICIENCY

The performance of appendages can be quantified by plotting the side force squared versus the total resistance. In this instance, a typical upwind sailing condition is presented, with low speed (Fn = 0.35) and high heel (20°), at leeway angles of 0°, 2°, 4° and 6°. For the results to be meaningful, they must be compared to the required side force upwind, depicted by the ‘upwind sailing’ line.

The best performance in terms of generating a given side force while creating the least resistance is achieved by both the keel alone first, and then the DSS. However, looking at the maximum side force that would be required to upwind, the keel only is superior in that portion where the realistic operation of the vessel would occur. Consequently, the additional drag generated by the presence of the hydrofoil is greater than any drag reduction due to the vessel lifting out of the water.



CONCLUSIONS

Hydrofoils are useless… hydrodynamically speaking on foil-assisted monohulls, where the reduction in displacement due to the lift is not sufficient to make up for the added drag resulting from the foil’s presence. In typical sailing conditions, the lowest drag is achieved without any foils.

However, to address the limitations of this study, restricted to hydrodynamic efficiency, current experiments are being undertaken to both quantify the added stability due to foils, and develop a custom velocity prediction programme to ascertain the fastest configuration.

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